

Nov. 29, 1960

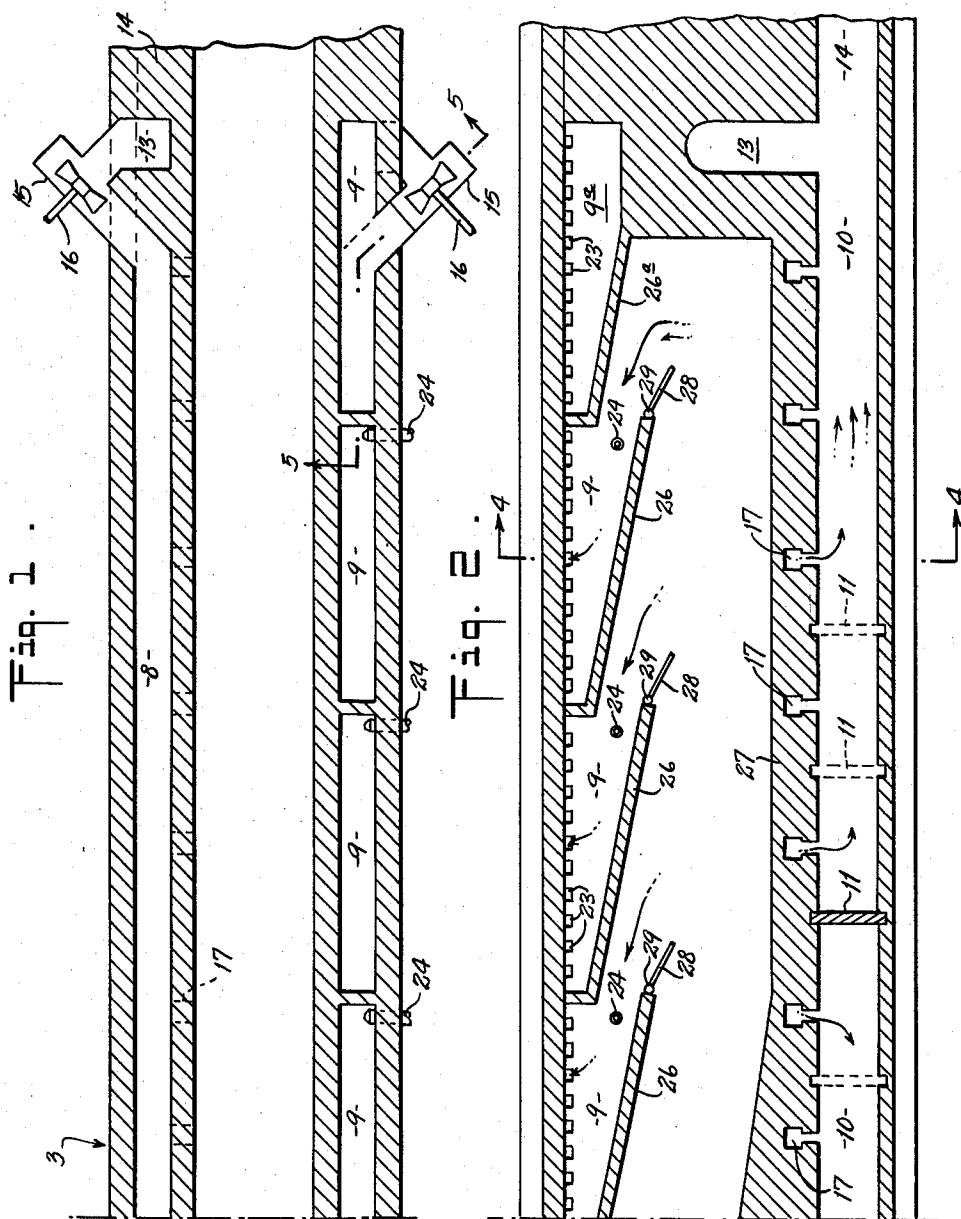
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PREHEATING SECTION FOR TUNNEL KILN AND METHOD

Filed June 18, 1957

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Fig. 1A.

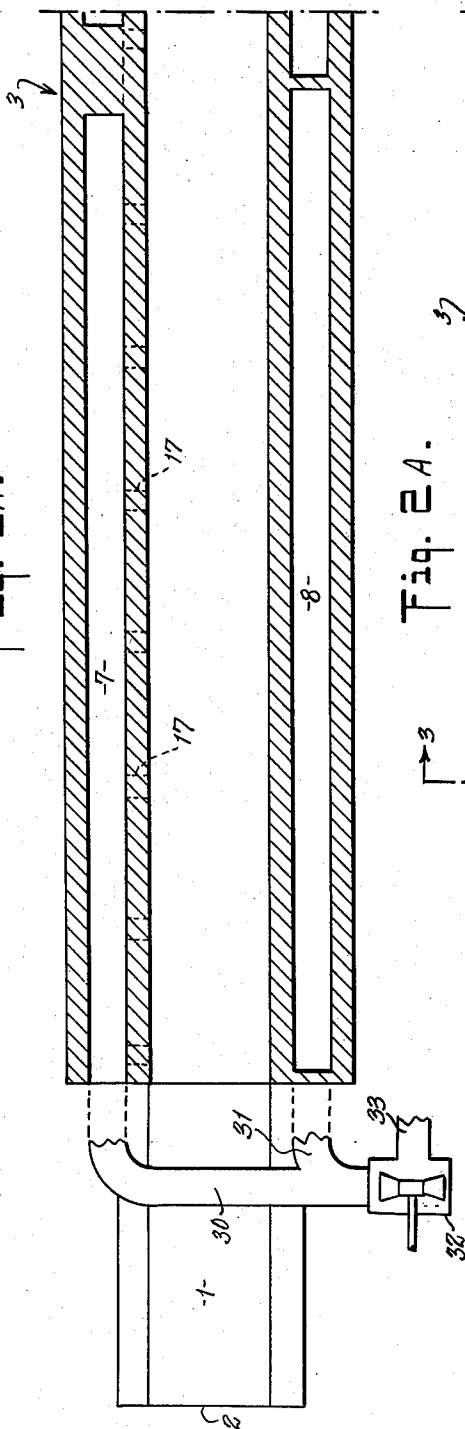
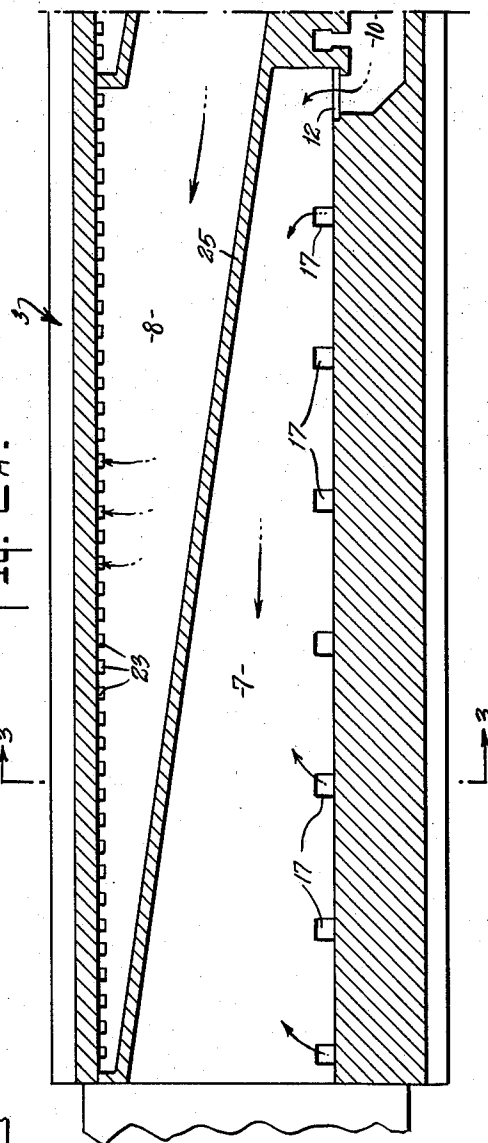


Fig. 2A.



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Fig. 3.

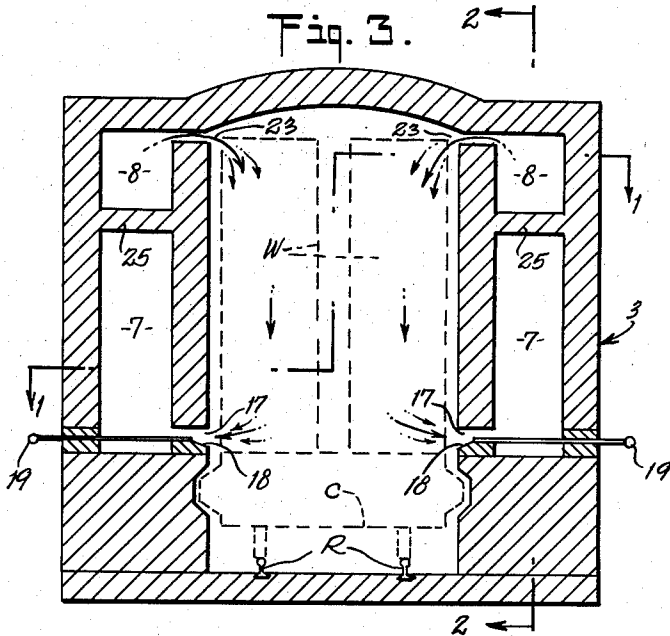


Fig. 5.

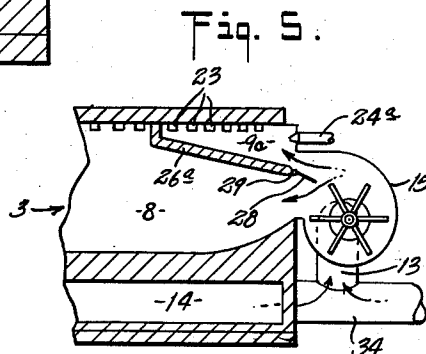
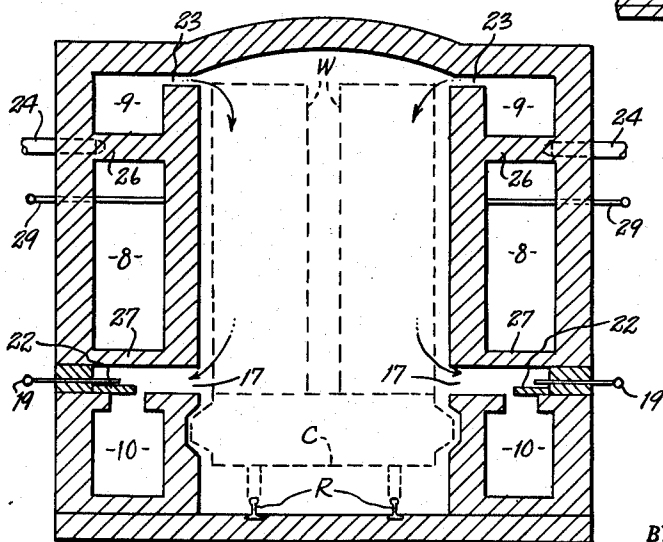


Fig. 4.



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PREHEATING SECTION FOR TUNNEL KILN AND METHOD

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9 Claims. (Cl. 25—142)

This invention comprises improvements in the construction of the preheating section of a tunnel kiln and in novel methods of operating tunnel kiln preheating sections.

One of the objects of this invention is to provide an improved preheating section for tunnel kiln in which provision is made for the recirculation of the heating gases in this zone for the purpose of heating under careful control the ware passing through the preheater to heat it to precise temperatures as it progresses there-through.

Still another object of the invention is to provide a structure in which higher temperatures for the ware are attained, so that it passes from the preheating zone into the hot zone of the kiln at higher temperatures.

Another object of the invention is to provide a mechanism by means of which hot gases are introduced into the preheating zone at temperatures which the circulating equipment can withstand, and thereafter raising the temperature of the gases to more rapidly heat the ware under controlled conditions to higher temperatures.

Still another object of the invention is to provide a preheating zone in which the circulation of the heated gases can be sectionalized to effect recirculation thereof in readily discernible sections of the preheater, whereby different heat cycles best adapted to the preheating of the ware can be effected.

Still another object of the invention is to provide a preheating zone in which a maximum amount of heat energy can be imparted to the ware with a minimum volume of gases being circulated.

Other objects of the invention include the provision of novel methods of operating tunnel kiln preheating zones to more efficiently and rapidly heat the ware to higher temperatures while circulating a minimum volume of heated gases.

Other and more detailed objects of the invention will be apparent from the following disclosure of one embodiment thereof and several methods of operating that embodiment.

In the accompanying drawings,

Figures 1 and 1A together comprise a longitudinal, horizontal, cross-sectional view on the line 1—1 of Figure 3 of a typical heater in accordance with this invention;

Figures 2 and 2A together comprise a vertical, cross-sectional view of the same structure taken on the line 2—2 of Figure 3;

Figure 3 is a transverse vertical cross-sectional view taken on the line 3—3 of Figure 2;

Figure 4 is a transverse sectional, cross-sectional view taken on the line 4—4 of Figure 2A; and

Figure 5 is a vertical, cross-sectional view taken on the line 5—5 of Figure 1A.

This invention is concerned with the preheating section of a tunnel kiln designed for firing clay products such as tile, brick, fire brick and the like, either of the glazed or unglazed types. As is well known, the dried, freshly molded ware is stacked on wheeled trucks which travel

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either continuously or intermittently through the kiln, entering the preheating section through an entrance housing. These trucks travel on rails mounted on the floor of the kiln and commonly are arranged in end to end contact so that they are pushed through by the newly entering trucks. As is of course well understood in the art, the purpose of passing the molded, dried ware through the kiln is to heat process it into a permanent hard structure with as little loss as possible due to such processing, and of course, as rapidly and with as little heat energy and as high efficiency as is possible.

Before describing the structure in the drawings in detail, it should be pointed out that there is illustrated therein what is known in the art as the preheating section of a complete kiln. It is to be understood, therefore, that the structure disclosed is the initial part of a whole assembly which includes the firing section and cooling sections, not shown in the drawings.

Those familiar with this art will understand that in the construction of such a kiln, including the preheating section, there is a suitable foundation and an overhead structural steel framework for supporting the kiln housing, which framework has been omitted for simplicity. The housing is constructed of brick and cement materials and those parts thereof which are exposed to the high temperature processing gases are constructed of refractory bricks and cement. No further special reference will be made to the materials of the housing in view of these well known facts.

At the receiving end there is provided a double walled housing 1, closed at its entry end by means of a door which can be opened for the introduction of cars and then closed to minimize the entry of outside atmosphere. The housing 1 is a continuation of the preheating section 3 and in combination therewith forms a tunnel in which tracks R, as diagrammatically illustrated in Figure 3 for example, are positioned. These tracks serve to guide wheeled trucks or cars C through the tunnel. These cars support the ware W stacked thereon in accordance with knowledge and experience in the art so as to occupy without obstruction substantially all of the available tunnel space above the car body.

As is clear from the drawings, the side walls of the preheating section are constructed to form longitudinally extending channels or ductways, which somewhere about midway of their length are divided into two sections 7 and 8 by means of an inclined baffle wall 25. The ductways sections 7 and 8, as is clear from the drawings, lie in part one above the other. Extending along each side of the housing and lying below the ductway 8 is a passage 10 which underlies the short portion of the ductway 7 and may communicate therewith through an opening controlled by a positionable damper 12.

The ductways 7 and 8 communicate with the main tunnel by means of ports 17 which lie at the bottom of the ductways and hence open into the main tunnel at about the level of the top of the car body as seen in Figure 3. The ports 17 are controllable in effective size by means of horizontal slidable dampers 18 controlled by rods 19 which project exteriorly of the housing 3. As is clear in Figure 3, the inner edges of the dampers 18 are wedge shaped to facilitate control of the effective passageway areas of the ports 17. The side wall of each passageway 10 is provided with longitudinally spaced slots through which a damper 11 may be slid at various longitudinal positions to change the effective length of the passage 10. Or to put it another way, to determine the portion of the hot gases which enter it through the ports 17 that will go to the right, Figure 2, and which portion may be sent to the left to be discharged through the port controlled by the damper 12 into the ductway 7.

Along the top of the main tunnel and extending

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throughout the length of the preheating section, are a series of ports 23 which establish communication between the ductway 8 and the main tunnel passage.

Extending across the ductway 8 towards the right-hand or hotter end of the preheating section, Figure 2, are a series of inclined baffle walls 26 which are relatively positioned to provide passages or ports, the effective area of which can be controlled by a series of dampers 28. These dampers are mounted on pivotally supported rods 29 which extend exteriorly of the main housing 3 at the sides, so that the relative angular positions thereof can be predetermined to control the amount of hot gases passing from the ductway 8 into the spatially arranged chambers 9, which are defined by the baffle wall 26 and associated dampers.

Positioned in the passageway into the chambers 9 are a series of burners 24, which extend through the outer wall of the housing, see Figure 4, and project into the chambers 9, so that the combustible gases are burned thereat to discharge the products of combustion into the vapor streams passing from the ductway 8 into the chambers 9.

At the extreme right or hot end of the preheater, is a baffle wall 26^a, which does not communicate with the ductway 8 to form a chamber 9^a.

At the end 14 of the passage 10 there is provided a duct 34 which extends to any suitable source of hot gases of the desired temperature, such as for example the succeeding firing section, not shown. The duct 34 is connected by a branch 13, a part of which is built into the housing 3, see Figure 2, which duct communicates with the intake of a power driven fan 15. The discharge end of the fan housing is arranged to deliver the hot gases into both the ductway 8 and the chamber 9^a. The passageway into the chamber 9^a is likewise provided with a damper 28 mounted on a control rod 29, so that the amount of hot gases delivered to the chamber 9^a can be controlled. At 24^a is a burner for discharging hot gaseous products of combustion into the gas stream passing through the chamber 9^a.

At the lefthand end or entry end of the preheating zone the ductway 7 is connected by a pipe 30 and branch 31, to the intake side of a power driven fan 32. The outlet connection 33 of this fan is provided for disposal of the waste gases after their use in the preheater. Since these gases contain a considerable amount of heat energy they are commonly carried to the drier, not shown, in which the freshly molded ware is dried in preparation for processing in the kiln.

In the operation of this preheater, hot gases from some suitable source, such as the firing section of the tunnel, are delivered at approximately 1200 degrees Fahrenheit to the intake of fan 15 through the duct 13. At this point it will be useful to note, as illustrated in Figure 1, that the fan 15 is supplied for each side of the preheating section, and so there will be a duct 34 for delivering such gases to the intake of each of these fans. A portion of this hot gas is discharged by fan 15 into chamber 9^a, where its temperature is raised as conditions require, as for example to from 1500 to 1600 degrees Fahrenheit by means of the burner 24^a. The hot gases thus further heated then pass through the ports 23 which open from the chamber 9^a into the main tunnel, as illustrated in Figure 2, so as to impinge upon and bathe the ware W on the truck or trucks at that position.

The larger portion of the gas stream from the fan 15 passes into the ductway 8 at the righthand end and travels therealong to the extreme lefthand end as indicated by the arrows. Portions of this stream pass by the dampers 28 and into the chambers 9 where those portions are raised in temperature by the addition of the products of combustion of the burners 24. From each of the chambers 9 these heated gases are discharged through the related sets of ports 23 into the top of the main tunnel to impinge upon the ware of the trucks at these positions. That por-

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tion of the stream passing into ductway 8 which does not come into the chambers 9 is distributed from the ductway 8 through the remaining ports 23 into the main tunnel, so as to impinge upon the ware at the related positions. Here again it is well to note that what occurs on one side of the preheating section also occurs in the same way on the other side, so that there are two sets of ports 23 distributed all along the top of the main tunnel to direct the hot gases onto the ware from each side, as clearly illustrated in Figures 3 and 4.

The hot gases then travel down over the ware stacks and are withdrawn from the region adjacent the bottom thereof through the ports 17. That portion of the withdrawn gases which passes through the ports 17 to the right of the damper 11, depending upon its position, passes into the righthand section of passage 10 and returns to the intake of fan 15, as is clear in Figure 5. Thus a portion of the heated gases which has contacted the ware towards the hotter end of the preheating section are returned for admixture with the fresh incoming gases carried from the source to the fan 15 by the duct 34. This is indicated by the confluence of arrows in that duct, see Figure 5. This portion of the hot gases is the relatively hotter portion to which further heat is added by admixture with fresh incoming gas from the source and by the burner 24^a. As before, a large part of this gas passes into the ductway 8 and is subdivided and discharged into the chambers 9 where further heat is added by the burners 24.

A controllable portion of the hot vapor leaving the main tunnel through the ducts 17, that is the portion passing through the ducts 17 to the left of damper 11 is discharged through the port controlled by the damper 12 into ductway 7 to commingle with the gases which enter that ductway through the ports 17 to the left of damper 12. The gases in the ductway 7 which have completed their work for preheating purposes are withdrawn by the fan 32 and disposed of through the duct 33. By way of explanation, it is noted with regard to Figure 1 that branch duct 31 like the duct 30, is connected to the ductway 7 on the lower side of the structure.

It will be recalled, see Figure 4, that the rate of flow of gases through the ports 17 into the passageway 10 can be controlled by the dampers 22. In passing it may be noted in conformance with the other temperature figures given, that the gases arriving at the intake of the fan 15 through the passage 10 will have a temperature of the order of 1200 degrees Fahrenheit.

Upon consideration it will be seen that there is a great deal of flexibility of control of the rate of heat input at different points in the preheater by reason of all of the adjustments which are provided. Assuming a constant rate of delivery of gases by the fan 15, it will be seen that the portion of the delivered gases entering the chamber 9^a can be controlled by the associated damper 28, and in addition that the amount of additional heat put into this portion of the gas can be controlled by adjusting the burner 24^a. It will also be seen that a similar control of the portion of the gases passing through the chambers 9 can be effected by the adjustment of the associated dampers 28 and the adjustment of the associated burners 24. Further control is had by the position at which the damper 11 is arranged and the adjustments of the dampers 22, so that the portion of the heated gases recirculated through passage 10 to the right of damper 11 can also be nicely controlled, as can the subdivided parts thereof which pass through the ducts 17 to the right of damper 11.

There is a further control involving the damper 11 and the damper 12, as well as the dampers 22 associated with the ducts 17 lying therebetween to predetermine the portion of the hot gases which are withdrawn from the process and commingle in ductway 7 with still another portion of the gases which are withdrawn through the ducts 17 to the left of the damper 12.

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Assuming, therefore, that the withdrawal ducts 17 are provided one or more for each car position, it will be seen that there is substantially individual control of the hot gas flow over the ware of each car. This statement applies with respect to the entire length of the preheating section, so that if operation dictates, as fine a subdivision, it can be effected as is desired. The result is that in the extreme the heating of the ware on each car can be individually controlled independently of the heating of the ware of any of the other cars or that practically any curve of temperature operation can be attained. In some cases the heat processing of the ware will require that the temperature curve flatten out for a time, so that at several car stations the temperature conditions may remain substantially constant, subjecting the ware to that processing temperature. In this connection it will be understood that more or less of the chambers 9 may be provided to meet substantially any temperature curve or range desirable within the limits of a process of this kind.

An important feature of the invention is found in the fact that the hot gases delivered to the fan 15 can be kept at or below a temperature which will damage the fan while permitting the introduction of additional heating and at various points along the preheater to meet the temperature requirements of preheating materials of this kind. By reason of the novel arrangement previously described it is possible to introduce enough additional heat to the processing gases after they pass fan 15, so as to raise the temperature of the ware by the time it reaches the exit ends of the preheating section and is about to enter the firing section of the kiln, with the result that the ware may move through the firing section faster because its temperature has been raised higher than has heretofore been practical in kilns of this type. The arrangement disclosed also permits of the control of the temperature of the gases returning through the passage 10 to the fan 15, so as to keep their temperature below a damaging temperature to the fan by tempering the fresh gases coming into duct 34.

Another very important feature of the invention is the close control which is attained over the total volume of gases in the process, keeping them by the recirculating feature at a minimum, and thereby reducing the energy requirements for moving these gases through the process. This is an important contribution to the overall efficiency of this preheating section.

It is apparent that the system is so devised that the ware may be heated continuously from the moment it enters the preheating to the time it leaves it, and at a higher but closely controlled rate so that the ware may move more rapidly through the preheating section as herein disclosed. Actual operating experience with this preheating section has indicated that the overall capacity of a kiln employing it can be increased as much as thirty percent over previous kilns, assuming, of course, that there are commensurate improvements in the firing and cooling sections of the kiln, which improvements will be the subject matter of other patent applications.

From the above description it will be apparent to those skilled in the art that the subject matter of this invention is capable of considerable variation in details of construction and operation, which variations have been indicated by the disclosure herein. As a result it is

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preferred that the scope of protection afforded by the patent granted hereon be determined by the claims rather than by the disclosure which is given in the spirit of exemplification.

What is claimed is:

1. A tunnel kiln preheater comprising an elongated refractory housing forming a processing tunnel through which stacks of ware to be heated are moved, a supply and an exhaust ductway in at least one wall of said housing, means for directing hot gases from said supply ductway, in subdivided streams, into said tunnel at longitudinally distributed zones therealong, means for withdrawing the gases from said tunnel at longitudinally distributed points below said first means into said exhaust ductway, and means for recirculating a portion of said withdrawn gases from said ductway to said first means and individual means in said supply ductway for introducing fresh heated gases at said zones into said streams respectively.

2. In the combination of claim 1, means for individually controlling the volume of gases entering the tunnel at each of said zones.

3. In the combination of claim 1, means for adjustably subdividing said exhaust ductway into at least two sections of different relative lengths.

4. In the combination of claim 1, said first means including a source of hot gases and a circulating fan, and said recirculating means including a connection to the intake of said fan.

5. In the combination of claim 1, means for subdividing said exhaust passageway into at least two sections to control the number of subdivided streams recirculated and hence the amount of gas exhausted through said exhaust ductway.

6. In the combination of claim 1, fuel burning means for supplying said fresh hot gases to said recirculating gases.

7. A process for preheating ware as disclosed, comprising the steps of moving the ware in stacks along an enclosed passageway, initially supplying hot gases into said passageway near the top in separate streams at a plurality of zones longitudinally spaced along said passageway, withdrawing the gases from said passageway at a plurality of longitudinally spaced points therealong near the bottom, mixing a portion of said withdrawn gases with fresh hot gases and returning said mixture to said passageway at said zones.

8. In the method of claim 7, the additional step of individually controlling the volume of gases recirculated to said zones.

9. In the process of claim 7, the additional step of exhausting the remaining portion of said withdrawn gases from the process.

References Cited in the file of this patent

UNITED STATES PATENTS

1,858,008	Forse et al.	May 10, 1932
1,923,729	Hull	Aug. 22, 1933
2,544,947	Baker	Mar. 13, 1951
2,550,807	Hanley	May 1, 1951
2,590,757	Cornelius et al.	Mar. 25, 1952

FOREIGN PATENTS

630,293	Great Britain	Oct. 10, 1949
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